Hierarchical Validation of GPM IMERG Products using Combined Radar and Rain Gauge Datasets

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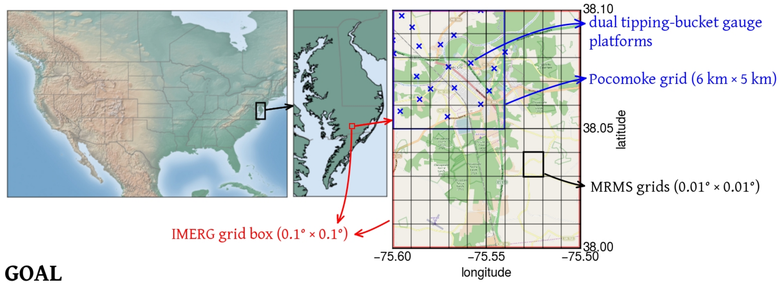
Approach



GOAL

Use highly-reliable gauge network in Pocomoke City, MD (PCMK) to validate the Multi-Radar Multi-Sensor (MRMS) rainfall product over the small scale, then use MRMS to validate Integrated Multi-satellite Retrievals for GPM (IMERG) over a larger region.

DATA

IMERG: GPM Level 3 product; 0.1° every 30 min covering up to ±60° latitude
MRMS: radar- and gauge-based estimate of rainfall; 0.01° every hour over CONUS (Stage III)
PCMK: dense network of gauges; highly reliable and regularly maintained by WFF

METHOD

We compare 11 months of data (Apr 2014 to Feb 2015) excluding days with snow and the day after. For comparisons with MRMS, we average to hourly accumulation to match the MRMS resolution. For analysis by platform, we remain at half-hourly resolution in order to precisely associate with the platform.

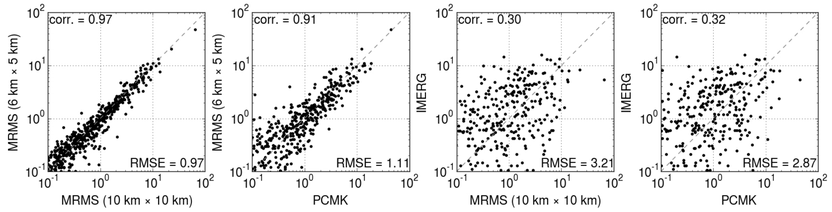
FUTURE WORK

Once available, we will use the half-hourly MRMS Stage III data. With the hierarchical validation (PCMK to MRMS to IMERG), we will evaluate IMERG categorized by platform over a large area for robust results. This bridges across Level 2 and 3 GPM products, allowing us to understand the connections between errors in rain estimation, rainfall properties from ground retrieval, and individual satellite platforms.

Summary

At pixel level, IMERG has considerable scatter when compared to PCMK and MRMS, and underestimates the number of rain events. Averaging over larger scales improves its accuracy. By categorizing the errors according to satellite platforms, we found that AMSR appears to overestimate rainfall while SSMI/S missed an extreme event. This illustrates the potential and feasibility of evaluating Level 2 products via IMERG.

IMERG Validation



(Far left) Comparison of MRMS over the two grids (Pocomoke grid and IMERG grid box) shows that grid difference is not a large factor. (Left) MRMS performs well compared to the gauges, especially at higher rain rates. (Right & far right) IMERG has considerable scatter compared to PCMK and MRMS, but there is no perceptible systematic bias.

	PCMK > 0.1	PCMK = 0
MRMS (6×5) > 0.1	392 (7.1%)	104 (1.9%)
MRMS (6×5) = 0	55 (1.0%)	4942 (90.0%)

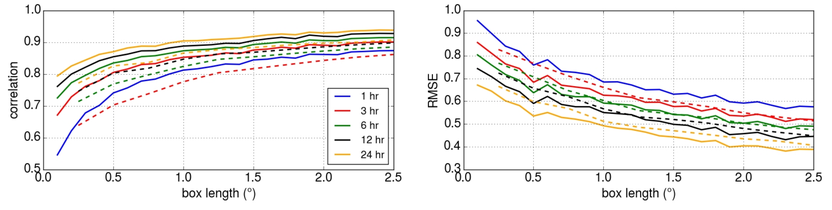
	MRMS (10×10) > 0.1	MRMS (10×10) = 0
IMERG > 0.1	282 (4.7%)	98 (1.6%)
IMERG = 0	282 (4.7%)	5372 (89.0%)

	PCMK > 0.1	PCMK = 0
IMERG > 0.1	282 (3.9%)	120 (1.7%)
IMERG = 0	231 (3.2%)	6509 (91.1%)

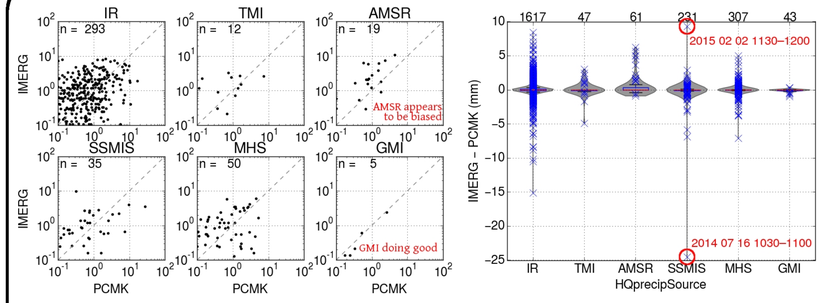
Contingency table of rain events (> 0.1 mm over 1 h) vs. no-rain events (zero rainfall) between the three pairs of data. Compared to PCMK, MRMS overestimates the number of rain events. On the other hand, IMERG underestimates the number of rain events, compared to both MRMS and PCMK.

Scale Analysis

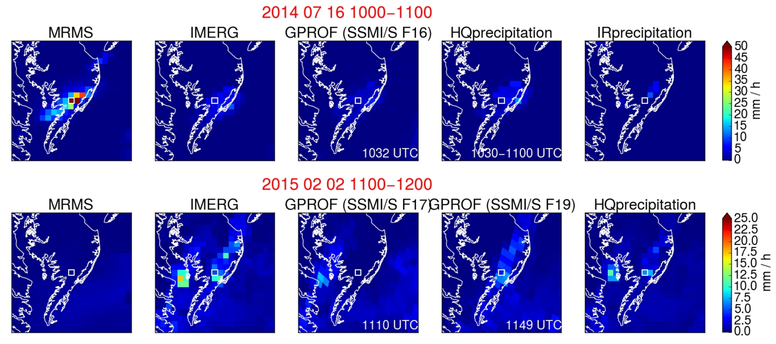
Averaging over larger grid boxes and longer periods increases the correlations and reduces the root mean square errors between IMERG and MRMS (solid lines) as well as TRMM 3B42 and MRMS (dashed lines) due to the reduction in random error. IMERG generally performs better than TRMM 3B42.



Platform Analysis



IMERG identifies the passive microwave satellite platform from the GPM constellation that provides the estimate. This establishes a connection between IMERG and GPM Level 2 products, allowing us to validate the estimation from each platform (above). We can also use MRMS to investigate the large scale picture of events in which the error is significant (below).



GPROF: GPM Level 2 product (single orbit estimate)
HQprecipitation: Level 2 interpolated to IMERG grid
IRprecipitation: IR rainfall (supplements microwave estimation)

Acknowledgments: We thank David B. Wolff for the Pocomoke gauge data and Wang Jianxin for the MRMS Stage III data. Insightful discussions with George J. Huffman and David T. Bolvin helped improve this study. IMERG can be downloaded at http://pmm.nasa.gov/data-access.

IMERG is provided by NASA PMM and PPS teams, which develop and compute the IMERG as a contribution to GPM, and archived at the NASA GES DISC. This research is supported by an appointment to the NASA Postdoctoral Program at Wallops Flight Facility, administered by Oak Ridge Associated Universities through a contract with NASA.